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**B7A ADL**

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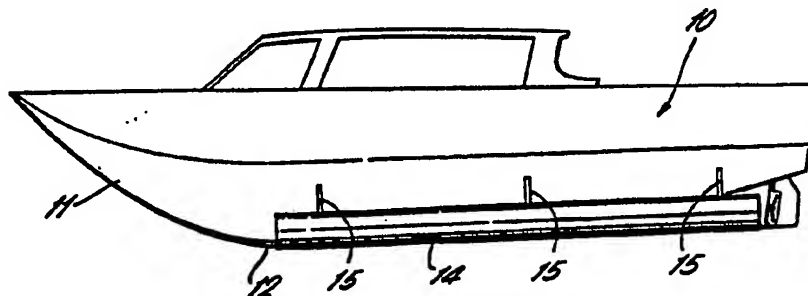
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 UK CL (Edition J) **B7A ADH ADL AED, B7V VAA**  
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(54) **Stabilising a water borne craft**

(57) Submerged stabilisers for water borne craft, in particular boats, ships and other floating vessels have previously generally only been effective in one plane of motion of the craft, are expensive and are difficult to fit retrospectively to existing craft.

The stabiliser of the invention includes an elongate passageway (13, 14, 23, 24, 26, 27, 33, 34, 43, 54, 55, 63, 64) open at each end to permit the free flow of water through it, and arranged such that when the craft (10, 40, 60) to which it is attached floats on water the passageway (13, 14, 23, 24, 26, 27, 33, 34, 43, 54, 55, 63, 64) is submerged and fills with water. The passageway is spaced from the axes of roll of the craft (10, 40, 60), and therefore reduces both the heeling and pitching instability of the craft.

FIG. 2.



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FIG. 1.

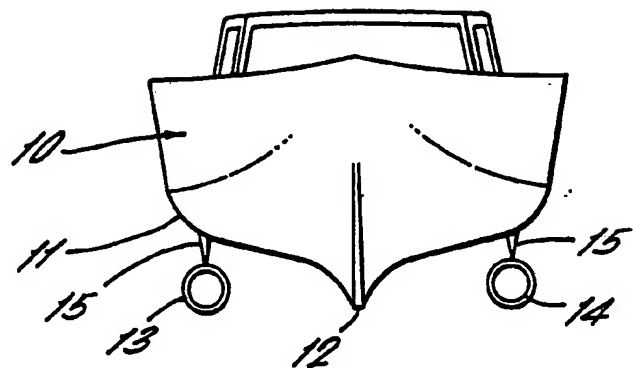


FIG. 2.

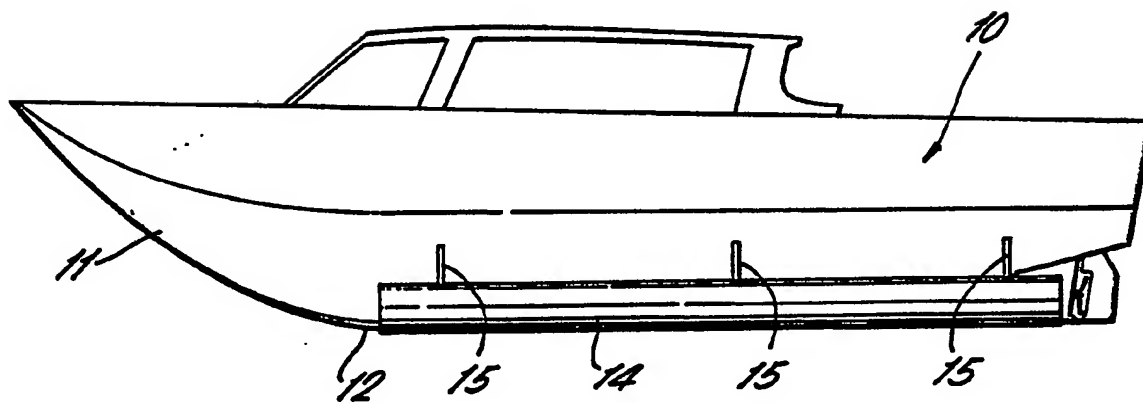


FIG. 3.

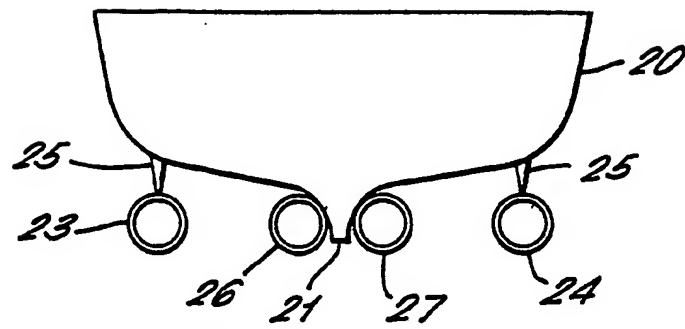
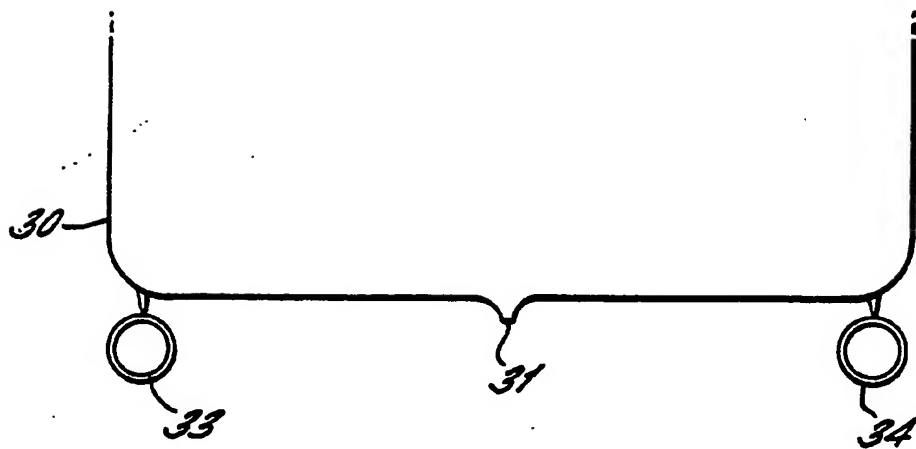


FIG. 4.



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FIG. 5.

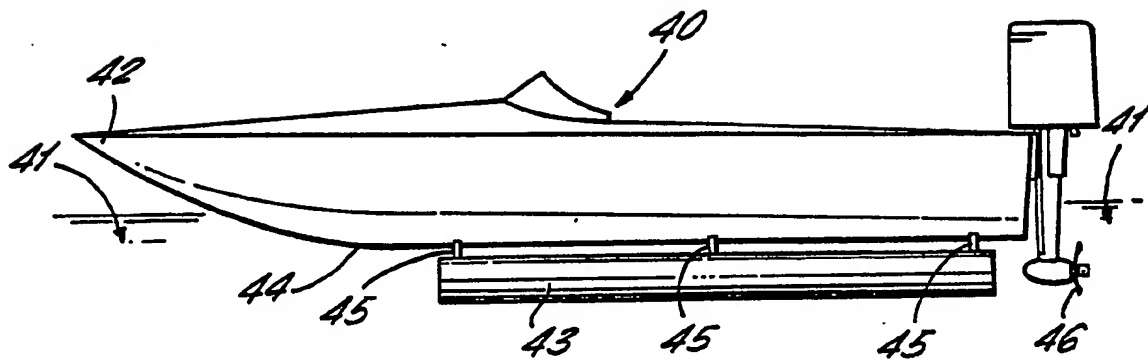
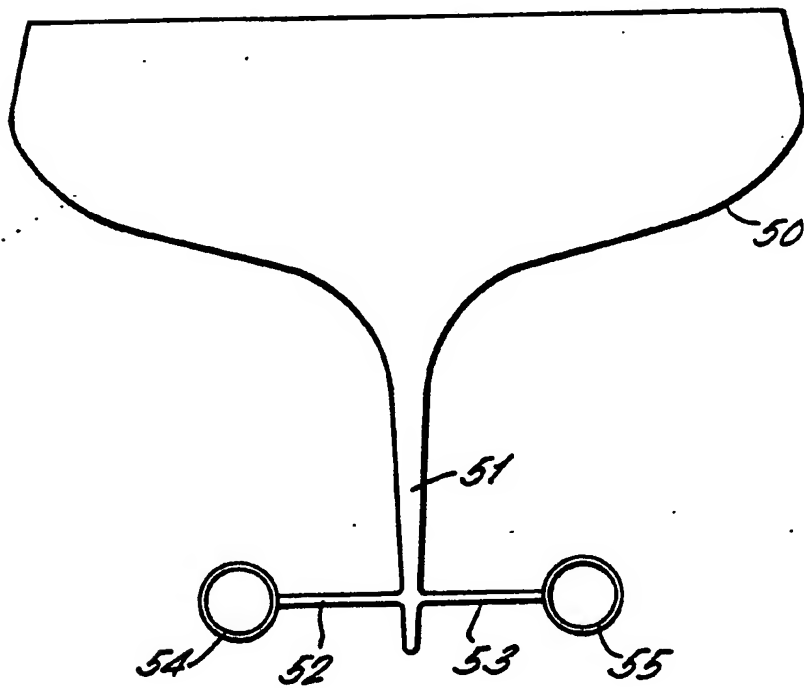
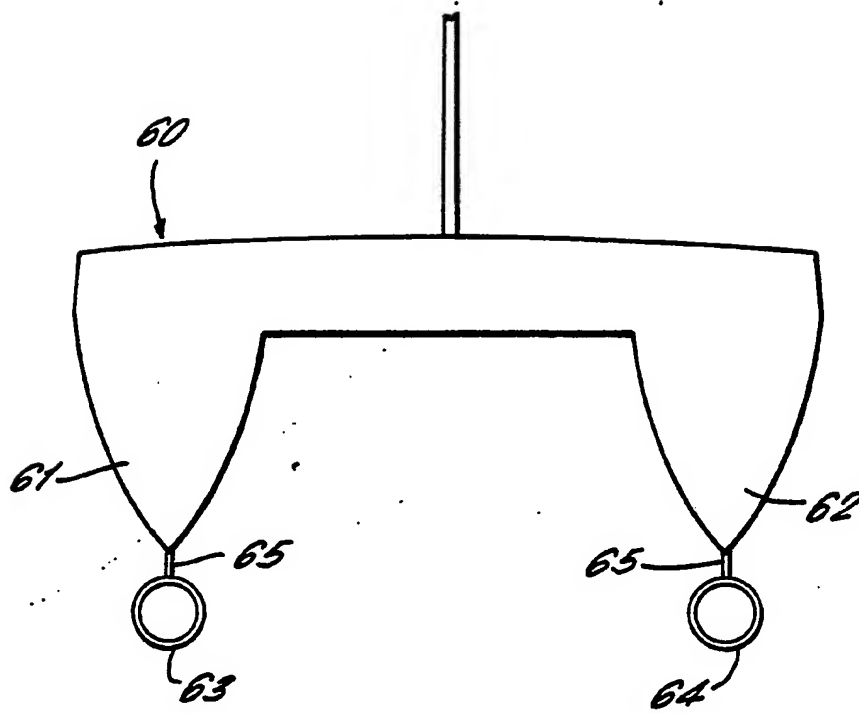


FIG. 6.



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FIG. 7.



APPARATUS FOR STABILISING A WATER BORNE CRAFT

The invention relates to apparatus for stabilising water borne craft. By "water borne craft" is meant yachts, dinghies, ships, power boats, floating structures such as cranes and pontoons, and the like.

The stability of a water borne craft is determined in terms of two axes of inclination of the craft, referred to herein as the heel and the pitch axes of the craft. The heeling of a water borne craft is an inclination in the transverse plane of the craft and is represented in a ship by rolling of the vessel from side to side; while pitching of a craft is an inclination in its longitudinal plane, ie along a line from bow to stern and vice versa. Clearly, under most normal circumstances a water borne craft experiences both heeling and pitching in combination at any given moment.

Various arrangements exist to improve the stability of water borne craft. In the case of ships, consideration is given to the heel and the pitch of the craft separately during the design thereof; however, in each case the design usually involves a compromise between reducing the extent to which the ship will roll in high seas; and reducing the danger of the ship entering a condition of unstable equilibrium and capsizing.

Large craft, such as ferries and liners, employ gyroscope stabilisers to overcome heeling instability. However, such apparatus is of necessity very large, and consequently can only be fitted at considerable expense, to large craft. Gyroscope stabilisers exhibit the disadvantage of accentuating pitch instability while correcting heel instability; further, they are of limited efficiency and cannot be

used in very heavy weather. Thus, there is a further requirement for stabilising apparatus which can be economically fitted to a range of sizes and types of craft, including stationary floating objects such as cranes and pontoons.

Accordingly, the invention provides a water borne craft comprising an elongate passageway open at each end to permit the free flow of water therethrough wherein, when the craft is borne by water, the passageway is submerged and is spaced from the axis of roll of the craft and increases the moment of inertia of the craft about said axis.

An advantage of this arrangement is that the apparatus may be arranged to reduce both heel and pitch instability in a water borne craft. A further advantage is that the apparatus can be cheaply fitted to craft of all sizes and types, either at the construction stage or after completion of the craft.

Preferably, the passageway extends generally in the fore and aft direction of the water borne craft.

This arrangement permits the flow of water longitudinally through the tube, thereby minimising possible resistance to movement of the craft which may be caused by the addition of the apparatus of the invention.

Preferably, the passageway lies generally perpendicular to the axis of pitch of the craft. In this way, a water borne craft may be stabilised in respect of both heel and pitch instability by the use of tubes only extending longitudinally along the hull of the craft.

More specifically, the passageway may be spaced from the axis of pitch of the craft.

This advantageously enhances the movement of force tending to oppose pitch instability of the craft.

Preferably, the cross-section of the passageway varies along the length thereof. More specifically, the passageway tapers from the aft to the fore of the craft. This feature avoids a build up of pressure in the passageway when water flows therethrough.

Preferably, the water borne craft comprises a plurality of such passageways.

More specifically, the craft may have first and second passageways connected to port and starboard portions with respect to the centre line of the craft. This arrangement permits symmetrically disposed tubes aligned with one another on opposite sides of the keel, thereby occasioning equal resistance to instability of the craft whether a clockwise or anticlockwise heel is encountered.

Preferably, the craft has a central keel, and includes a passageway located adjacent the keel. More specifically, the craft comprises a pair of generally parallel passageways located adjacent the keel and respectively disposed on opposite sides of the keel. Thus, the tubes may be centrally located on the underside of the hull of a water borne craft. This is particularly advantageous for relatively small craft.

Further, the craft may have a central keel, and may comprise a plurality of passageways respectively distributed on either side of said keel. More specifically, a first pair of parallel passageways may be respectively located adjacent said keel on opposite sides thereof; and a second pair of parallel passageways may be respectively spaced from said keel on opposite sides thereof. This is particularly advantageous for medium-sized craft.

The craft may have a keel, and the keel may include a downwardly extending fin, first and second passageways respectively being located on opposite

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sides of said fin. Such fins are commonly used on racing yachts.

5 More specifically, the first and second passageways are spaced from the fin by respective laterally extending wing members. Using this arrangement, the dual advantage given by the effect of the wing members and the apparatus of the invention is available.

10 Preferably, the position of the or any passageway is adjustable with respect to the craft. Thus, variations in loading, speed and sea conditions may be allowed for by adjusting the apparatus of the invention.

15 It is further preferable that the or any passageway is discontinuous along the length of the craft. Further, the or any passageway may have at least one further aperture in addition to that at each end of the tube. Thus, the apparatus may be manufactured and fitted economically, and may be  
20 adapted to take account of localised flow conditions in particular regions of the hull of the craft to which it is secured.

The or any passageway may either be formed integrally with the body of the craft, or may be  
25 formed as a hollow tube secured by securing means on the exterior of the craft.

There now follows a description of six specific embodiments of the invention, by way of example, reference being made to the accompanying drawings in  
30 which:

Figure 1 is a front elevational view of a small boat between approximately twelve metres and thirty metres in length and showing a first preferred embodiment of the invention;

35 Figure 2 is a side elevational view of the boat of Figure 1;

Figure 3 is a cross-sectional view showing a second preferred embodiment of the invention fitted to the hull of a medium size ship between approximately thirty metres and seventy five metres in length;

Figure 4 is a similar cross-sectional view showing a third preferred embodiment of the invention suitable for ships of greater than approximately seventy five metres length;

Figure 5 is a side elevational view of a fourth preferred embodiment of the invention suitable for use on a power boat;

Figure 6 is a schematic cross-sectional view of a fifth preferred embodiment of the invention for use on a yacht; and

Figure 7 is a front elevational view of a sixth preferred embodiment of the invention for use on a multi-hulled craft such as a catamaran.

Referring firstly to Figures 1 and 2, there is shown a small offshore cruising boat 10 between twelve and thirty metres in length. The boat 10 has a hull 11 and a central keel 12 which provides a longitudinal axis of symmetry of the boat. A pair of elongate, hollow tubes 13, 14 is suspended from the hull 11 by a series of pylons 15. The tubes 13, 14 are disposed generally parallel to one another extending longitudinally along the boat 10, respectively on opposite sides of the keel 12. The tubes 13, 14 are spaced downwardly of hull 11 a short distance by the pylons 15, and are so arranged that when the boat 10 is floating in water the tubes are completely submerged.

When the boat 10 is floating in the water, therefore, the tubes 13, 14 fill with water through the open ends thereof. Even when the boat 10 is moving, the tubes remain filled with water.

When the boat 10 experiences a heel inducing impulse about the longitudinal axis of roll thereof, the moment of inertia of the boat about that axis is what determines the extent to which the boat 10 will heel. Since the tubes 13, 14 are spaced from the axis of roll of the boat, when they are full of water they confer an increased moment of inertia on the boat as compared with the hull alone, thereby reducing the heel of the boat. The boat 10 is thus stabilised in terms of heel instability by the mass of water contained in the tubes 13, 14.

The tubes 13, 14 also stabilise the boat in terms of longitudinal instability, ie pitching about an axis perpendicular to the longitudinal axis of the boat 10. This is because the tubes lie perpendicular to the axis about which longitudinal pitching of the boat 10 may take place, and therefore when the tubes are full of water, the moment of inertia of the boat 10 is increased about its axis of longitudinal pitching. This is both because of the length of tube 13, 14 full of water extending away from the fulcrum of longitudinal pitching, and because the tubes 13, 14 are downwardly spaced from the axis of longitudinal pitching under most circumstances. Only when the boat rises high out of the water and pitches about an axis passing through the tubes 13, 14 will the latter effect referred to above be negligible.

It has been found that, if a tube of constant cross-section is used, when the boat 10 travels at speed, or a fast current of water passes along the tube, water pressure builds up in the tube. Therefore, the tubes 13, 14 have a slight taper from aft to fore of the boat 10, ie the tubes 13, 14 are of slightly larger diameter at the stern of boat 10 than at the bow. Only a very slight taper of, for example, 0.25 degrees is necessary to alleviate

pressure build-up, so this feature is not visible in Figures 1 and 2.

Referring now to Figure 3, there is shown a schematic cross-sectional view of a second preferred embodiment of the invention. This embodiment is particularly suitable for boats of between approximately 30 metres and 75 metres in length.

Figure 3 shows a boat hull 20 having tubes 23, 24 supported on pylons 25 in an analogous manner to those of the embodiment of Figures 1 and 2. The tubes 23, 24 are similar in structure and relative location on the hull 20 to tubes 13 and 14 of Figure 1.

Hull 20 has additional generally parallel, hollow open-ended tubes 26, 27 mounted longitudinally along the boat adjacent the keel 21 thereof. Tubes 26 and 27 are respectively disposed on opposite sides of the keel and function in a similar manner to tubes 23 and 24, and to tubes 13 and 14 of Figure 1. The tubes 26 and 27 are included in the embodiment of Figure 3 to provide extra stability in the longitudinal direction of the boat. The tubes 26 and 27 need not, in the embodiment of Figure 3, be mounted on lengths of the hull 20 corresponding to those on which tubes 23 and 24 are mounted. For example, tubes 23 and 24 may extend substantially along the entire length of hull 20, while tubes 26 and 27 may only extend along, say, a rear section of the hull 20. The tubes of Figure 3 may also have the taper referred to in relation to Figures 1 and 2.

Figure 4 shows an embodiment of the invention particularly suitable for large sized ships. Such craft include those greater than approximately 75 metres in length. These ships are usually flat hulled as shown. Reference numeral 30 denotes the hull.

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A long ship, as shown in Figure 4, suffers pitching instability to a lesser extent than shorter ships. Therefore, only two tubes 33 and 34, arranged as shown towards the outer edges of the longer sides of the base of the hull 30, are required. The tubes 33 and 34 operate in the manner described in relation to the other embodiments disclosed herein predominantly to reduce the heel instability of the ship. The tubes 33 and 34 may also have the taper referred to previously.

Keel 31 of hull 30 provides an axis of symmetry on either side of which the pylons 35 are distributed in order to support the tubes 33 and 34.

Figure 5 shows a fourth preferred embodiment of the invention suitable for use on a power boat such as 40. Control of the heeling instability of a powerboat is effected predominantly by the speed at which the boat makes a turn and the radius of curvature negotiated.

However, the pitching instability of a powerboat is a critical factor, since the boats tend to lift prow first out of the water 41 at speed, making them susceptible to flipping over backwards when an unexpected wave or object is encountered.

The embodiment of Figure 5 reduces the pitch instability of the power boat by having a single, elongate tube 43 open at each end mounted centrally under the keel 44 of the boat 40 on pylons 45.

Tube 43, when full of water, has some effect on the heeling instability of the boat, but not to the extent of those embodiments wherein two or more tubes are distributed to either side of the keel.

The pitching instability of the power boat 40 is considerably improved by the single tube 43 aligned perpendicular to the pitching axis of the craft and operating similarly to the tubes referred

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to in relation to the other embodiments of the invention previously described. Tube 43 may be tapered, as previously described.

5 The increased friction experienced by a power boat 40 fitted with the tube 43 of Figure 5 is offset  
by the fact that, with the improvement in pitching instability accorded by the apparatus of the invention, the screw 46 remains in contact with the water 41 beneath the boat 40, since the boat tends  
10 not to jump out of the water, and consequently the efficiency of the drive of the boat 40 is improved.

Figure 6 shows a fifth preferred embodiment of the invention which is particularly but not exclusively suitable for yachts.

15 A yacht hull 50 is shown having a deep keel 51. A pair of horizontal fins 42, 53 respectively extend on opposite sides of the keel adjacent the lowermost point thereof. The outer extremity of each fin 52, 53 has a corresponding tube 54, 55 attached  
20 of the type referred to in relation to the other embodiments of the invention described herein. These tubes, too, may be tapered to avoid water pressure build-up therein. Each fin 52, 53 extends such that its corresponding tube 54, 55 is between  
25 approximately half way and two thirds of the way between the keel and the corresponding outermost extremity of the hull 50.

Operation of the tubes 54, 55 takes place in a similar manner to that already described, but the  
30 effect of the keel 51 and fins 52, 53 in spacing the tubes 54, 55 a long way from the axes of instability of the yacht enhance the stability thereof still further.

Moreover, the known advantage associated with  
35 finned yacht keels can be included in the embodiment of the invention shown in Figure 5.

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Figure 7 shows a sixth preferred embodiment of the invention which may be used on multi-hulled craft. Figure 7 shows a front elevational view of a catamaran 60, but it will be appreciated that similar arrangements could be derived for multi-hulled craft having a greater number of hulls.

Catamaran 60 has starboard 61 and port 62 hulls, each having supported beneath it a corresponding elongate tube 63, 64 which is similar in appearance and function to tubes described hereinabove in relation to other embodiments of the invention. The tubes 63, 64 are supported on suitable mountings 65 and may be tapered towards the fore of the craft.

The axis of roll of the catamaran 60 is spaced from the tubes 63, 64, so a significant reduction in both heeling and pitching instability may be obtained. However, a variety of other arrangements of tubes may be possible in relation to multi-hulled craft. For example, a tube such as 63 or 64 may be supported centrally between two adjacent hulls 61, 62.

It will be clear from the foregoing that the apparatus of the invention may take a variety of forms and is not restricted to the embodiments described herein.

In particular, the tubes of the invention need not necessarily be mounted on pylons, but could instead be faired in to the structure of the hull of the craft during construction, or made integrally with the hull. However, the use of pylons or other, similar support means allows the apparatus to be economically fitted to existing craft not having it as original equipment.

Further, the tubes need not be continuous along the length of a hull. For example, a hull could be fitted with a series of tubes aligned end-to-end

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along its length; alternatively, front and rear tubes only may be sufficient for some applications. The tubes may also contain or work in conjunction with aerodynamic aids such as fins, slots, apertures  
5 baffles, chokes and the like.

The positions of a tube may be adjustable with respect to the hull to which it is fitted, to take account of prevailing conditions.

10 Tests on the apparatus of the invention involving moving scale models of boats have shown that the flow of water through the tubes is laminar for most speeds of operation, and consequently the tubes remain filled with water at all times. Reductions in heeling instability of at least 50%  
15 have been obtained.

The increased friction experienced by a craft to which the apparatus of the invention is fitted is generally offset by improvements in the drive efficiency of the craft. This is because much of the  
20 energy in a rotating boat propellor is dissipated when the boat heels or pitches.

The tubes described and shown herein are straight tubes of constant, circular cross-section. However, a great variety of cross-sections and tube  
25 profiles is possible. Further, the tubes need not be straight and may have, for example, curved shapes to conform to the hull shape of a boat.

Variations of profile, shape and cross-section are possible both from place to place within  
30 individual tubes, and from tube to tube on a particular craft.

Further, the tubes may be fitted with apparatus for closing some of the apertures therein, or for altering the orientations of the tubes.

35 In addition to the variety of craft described above to which the apparatus of the invention may be

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fitted, the apparatus may also be fitted to fully or partially amphibious craft and hovercrafts.

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CLAIMS

1. A water borne craft comprising an elongate  
5 passageway open at each end to permit the free flow  
— of water therethrough wherein, when the craft is  
borne by water, the passageway is submerged and is  
spaced from the axis of roll of the craft and  
increases the moment of inertia of the craft about  
10 said axis.
2. A water borne craft as claimed in Claim 1  
wherein the passageway extends generally in the fore  
and aft direction of the water borne craft.  
15
3. A water borne craft as claimed in any preceding  
claim wherein the passageway lies generally  
perpendicular to the axis of pitch of the craft.
- 20 4. A water borne craft as claimed in Claim 3  
wherein the passageway is spaced from the axis of  
pitch of the craft.
5. A water borne craft according to any preceding  
25 claim, wherein the cross-section
6. A water borne craft as claimed in Claim 5  
wherein the passageway tapers from the aft to the  
fore of the craft.
- 30 7. A water borne craft as claimed in any preceding  
claim comprising a plurality of such passageways.
8. A water borne craft as claimed in any preceding  
claim having first and second tubes connected to port  
35 and starboard portions with respect to the centre  
line of the craft.

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5 9. A water borne craft as claimed in any preceding claim wherein the craft has a hull and a central keel, and the or at least one passageway is directly or indirectly secured to the hull.

10 10. A water borne craft as claimed in Claim 9 comprising a pair of generally parallel passageways located adjacent the keel and respectively disposed on opposite sides of the keel.

15 11. A water borne craft as claimed in any preceding claim wherein the craft has a central keel, and comprising a plurality of passageways, respectively distributed on either side of said keel.

20 12. A water borne craft as claimed in Claim 11 wherein a first pair of parallel passageways is respectively located adjacent said keel on opposite sides thereof;

and wherein a second pair of parallel passageways is respectively spaced from said keel on opposite sides thereof.

25 13. A water borne craft as claimed in any preceding claim wherein the craft has a keel, said keel including a downwardly extending fin, and wherein first and second passageways respectively are located on opposite sides of said fin.

30 14. Apparatus as claimed in Claim 13, wherein the first and second passageways are spaced from the fin by respective laterally extending wing members.

35 15. Apparatus as claimed in any preceding claim wherein the position of the or any passageway is

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adjustable with respect to the craft.

16. A water borne craft as claimed in any  
preceeding claim wherein the passageway is integrally  
5 formed with the body of the craft.

17. A water borne craft as claimed in any of Claims  
1 to 14, wherein the or any passageway is formed as a  
hollow tube secured by securing means on the exterior  
10 of the craft.

18. Apparatus generally as herein described, with  
reference to and as illustrated in the accompanying  
drawings.

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